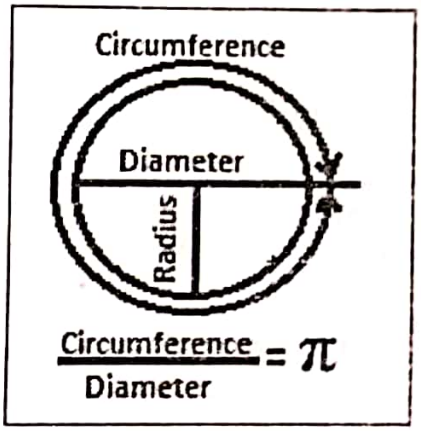
SHORT QUESTIONS

Write short answers of the following questions.

1. Define the number π and show that 2π radian = 360°.



Ans. The number π is defined as;

"The ratio between the circumferences "C" of a circle to the diameter "d" of the same circle".

According to definition

$$\text{Ratio of Circumference to diameter} = \frac{C}{d} = \pi$$

2π radian = 360°

Since the angle subtended by the circumference at the centre of a circle in one complete revolution is 360° or one revolution, therefore we write as;

For 1 rev, $\theta = 360°$ (1)

Also $\theta = \frac{S}{r}$ (2)

For one revolution $S = 2\pi r$

Eq. 2 becomes; $\theta = \frac{2\pi r}{r} = 2\pi \text{ rad}$ (3)

By comparing Eq.1 and Eq.3, we get;

$$2\pi \text{ rad} = 360°$$

2. Define the terms error, uncertainty, precision and accuracy in measurement.

Ans. Refer to theory.

3. Explain several repetitive phenomena occurring naturally which could serve as reasonable time standards?

Ans. Phenomena repeating after regular intervals of time can be used as a time standard.

a. Heart beat
b. Stages of the moon
c. Change in seasons
d. Sun set and sun rise.
e. The rotation of the earth about its axis.
f. Characteristic vibrations of crystals such as Quartz crystal.
g. Transition of electrons between electronic levels.

4. Why do we find it useful to have two units for the amount of substance, kilogram and mole?

Ans. Kilogram is useful to be used as unit whenever we want to consider a specific quantity of mass without considering the number of microscopic atoms or molecules present in it. Kilogram and mole really measure two very different things. Kilogram is used to measure the mass; the mole is closely related to the number of particles. 1 mole of a substance always has Avogadro number of particles. Therefore, one can't say in general that a kilogram is so-and-so many moles; this depends on the substance. For example, a mole of hydrogen atoms has a mass of 1 gram, while a mole of oxygen atoms has a mass of 16 grams.

Importance of Mole

Imagine the reaction between two atoms. We'll pick Hydrogen and Chlorine. Now, these atoms combine to form HCl, or hydrochloric acid. Now, let's assume that we want to make some HCl. We would need one atom of Hydrogen for every atom of Chlorine. When we weigh the hydrogen, it's much lighter than the chlorine. If we were to add 1 gram of hydrogen to 1 gram of chlorine, there would be greater number of hydrogen than chlorine. So we need some other way to make sure that the number of atoms in each sample is equal. We do this using the molar weight. When we add one mole of hydrogen to one mole of chlorine, we would have a balanced reaction. This is why mole is useful for us. Mole allows us to mix equal number of particles with each other. Moreover mole is scientific approach to measurement.

5. Show that the famous "Einstein equation" $E = mc^2$ is dimensionally consistent?

Ans. As the Einstein's equation is given by; $E = mc^2$

L.H.S. Dimensions of $E = [J] = [N\ m] = [(kg\ m/s^2)\ m] = [kg\ m^2/s^2]$

$[E] = [M\ L^2\ T^{-2}]$ (1)

R.H.S. Dimensions of $mc^2 = [kg\ (m/s)^2] = [M\ L^2\ T^{-2}]$ (2)

Comparing 1 & 2, we come to know that the Einstein's equation is dimensionally correct.

6. Deduce the dimensions of gravitational constant G ?

Ans. The gravitational force is given by;

$$F_g = G\ \frac{M_e\ m}{r^2}$$

$$\Rightarrow \quad G = \frac{F\ R_e^2}{M_e\ m} = \frac{N\ m^2}{kg^2} = \frac{kg\ ms^{-2}}{kg^2} = kg^{-1}\ m\ s^{-2} = [M^{-1}L^3T^{-2}]$$

7. Find the dimensions of Kinetic Energy ?

Ans. The K.E is given by; $K.E = \frac{1}{2}\ m\ V^2$

Since the unit of kinetic energy is joule, therefore the dimensions of K.E are:

$$[J] = [N\ m] = [(kg\ m/s^2)\ m] = [kg\ m^2/s^2]$$

8. Give the drawbacks to use the period of a pendulum as a time standard?

Ans. The time period of the simple pendulum is;

$$T = 2\pi \sqrt{l/g}$$

It clear from above equation that the time period depends upon;

a. Length of the metallic wire of pendulum
b. Gravity

Since the length of the metallic wire changes with change in temperature so its time period will be affected accordingly. Also the value of the gravitational acceleration changes from place to place therefore pendulum is not suitable for time standard.

9. Are radians and steradians the basic units of SI? Justify your answer.

Ans. The general conference on weight and measures has not yet classified certain units of SI under either base units or derived units. These SI units are called as supplementary units. Till now this class contains only two units of purely geometrical quantities. They are:

i. Plane angle (two dimensional angle) measured in radians
ii. Solid angle (three dimensional angle) measured in steradians

RADIAN

It is the unit of plane angle and it is defined as;

"One radian is the angle between two radii of the same circle subtended by an arc equal in length to the radius of the circle".

Which gives purely a number, hence it cannot be SI unit.

STERADIAN

"One Steradian is the angle subtended at the centre of a sphere by an area of its surface equal to the square of radius of the sphere".

Which also gives purely a number, hence it cannot be SI unit.

10. What does the word "micro" signify in the words "micro wave oven"?

Ans. Microwaves are electromagnetic radiation with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 300 MHz (0.3 GHz) and 300 GHz.

The prefix "micro-" is a Greek word which means "small". The prefix "micro-" in "microwave" literally shows the smallness of the microwaves as compared to radio waves. It has not been used scientifically to mean 10^{-6} m. It indicates that microwaves are "small" compared to waves used in typical radio broadcasting, in that they have shorter wavelengths.

In a typical microwave oven, the frequency is 2,450 MHz which corresponds to a wavelength range of 12.2 cm or 122 mm.

11. Density of air is 1.2 kgm^{-3}. Change it into g cm^{-3}. (1.2×10^{-3} g cm^{-3})?

Ans.

$$\rho = 1.2 \times kg\ m^{-3} = 1.2 \times 1000\ g \times 10^{-6}\ cm^{-3}$$

$$\rho = 1.2 \times 10^{-3}\ g\ cm^{-3}$$

12. An old saying is that "A chain is only as strong as its weakest link. What analogue statement can you make regarding measurement?

Ans. An analogue statement to the given statement regarding measurement is:

"The result of a measurement is only as accurate as its least accurate measurement".

13. Differentiate between the Light year and year?

Ans.

Year	Light year
1. The duration of time in which earth completes one revolution around sun is called as one year. 2. It is the unit of time. 3. The duration of time in 1 year = $365 \times 24 \times 3600$ 1 year = 31536000 s	1. It is the distance covered by light in one year. 2. It is the unit of length. 3. Distance covered in one light year is; $S = V \times t$ $S = c \times t = 3 \times 10^8 \times 31536000$ $S = 94608000 \times 10^8 \text{ m} = 9.46 \times 10^{15} \text{ m}$